

Economic Impact of the Biopharmaceutical Sector on New York State

Appendix to Report

Prepared by: Archstone Consulting LLC

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APPENDIX I: Case Studies

Case Studies – Madison, Wisconsin and Frederick, Maryland

Other states and regions have attempted to develop their biopharmaceutical industries by supporting biopharmaceutical clusters. This report will look at two examples – Madison, Wisconsin and Frederick, Maryland – to understand the activities and successes each region has had.

Biopharmaceutical Sector's Impact on Frederick, Maryland^d

The impact of the biopharmaceutical sector is felt nationwide. In some states, clusters of biopharmaceutical firms and institutions have developed and are creating positive effects in their local communities. The city of Frederick, Maryland is a prime example of how the introduction and growth of a biopharmaceutical presence can transform local and state economies.

Over the span of 15 years, the state of Maryland grew a fledgling biopharmaceutical industry of about two dozen companies into the third largest biopharmaceutical cluster in the U.S., with more than 370 biopharmaceutical companies that generate \$11.1B in total output and \$600M in state taxes annually. Additionally, venture capital investment for biotechnology in Maryland reached nearly \$250 million in 2006. Research expenditures totaled \$1.5B in 2006 alone.

This tremendous growth and investment is the result of a combination of several factors, including the availability of a highly-skilled workforce, aggressive state and local government economic development programs, and proximity to government and academic research institutions. The city of Frederick, Maryland is a prime example of how the introduction and growth of a biopharmaceutical presence can transform local and state economies.

Biopharmaceutical corporations began migrating to Frederick in the late 1990's, attracted by its convenient location on the northern end of the I-270 Technology Corridor, ready-access to a highly-educated labor force, and close proximity to Fort Detrick, home to a large number of medical research institutions. Between 1999 and 2003, more than 10,000 new jobs were added in Frederick County, across numerous sectors, making its annual growth rate 13.4%, the highest in the state. Between 2002 and 2006, employment growth remained impressive, with the addition of 5,600 new jobs within the city limits of Frederick. Given that approximately 1,800 of these new jobs were provided directly by the biopharmaceutical industry, and that for every biopharmaceutical job created at least one additional job was supported indirectly, the area's rapid growth can largely be attributed to the biopharmaceutical sector. Currently, 42% of the more than 60 biopharmaceutical companies in Frederick County reside within the city limits of Frederick, with the top five biopharmaceutical employers providing more than 6,300 jobs.

Considering that the average biopharmaceutical company in Frederick generates \$98M in revenues per year, and that the average biopharmaceutical employee earns a salary of \$108,000 and generates \$215,000 in revenues per year, the sector brings considerable economic value to the city.

Biopharmaceutical companies continue to be successful in promoting local employment, as evidenced by the announcement that MedImmune, a wholly owned subsidiary of AstraZeneca, would expand its Frederick operations by investing \$250 million in a new manufacturing facility, which is expected to provide 800 new area jobs by the end of 2009.

Biopharmaceutical Cluster in Madison, Wisconsin

Bolstered by world-class academic research institutions and favorable state economic policy, Wisconsin is considered among the top biopharmaceutical regions in the nation. By 2006, Wisconsin biopharmaceuticals generated total output of \$3.1B and supported total employment of approximately 14,000 people. One third of the 248 biopharmaceutical companies operating in Wisconsin in 2006 emerged during the previous five year period. The development of this biopharmaceutical cluster has been significantly aided by the Wisconsin state government, which offers a variety of tax credits, grants, and bridge loans to provide financial support to startups. Additionally, statewide academic research expenditures totaled \$765M in 2006, which can largely be attributed to the eleven universities that comprise the University of Wisconsin System.

The University of Wisconsin-Madison is the focal point of academic biopharmaceutical research in Wisconsin, making Madison the center of the state's biopharmaceutical industry. The University of Wisconsin-Madison is largely credited with the grassroots growth of the Wisconsin biopharmaceutical cluster. The university is among the top ten largest biopharmaceutical research institutions nationally, supporting over 800 bioscience faculty and 10,000 active research projects. Not surprisingly, the university is the birthplace for many of the biopharmaceutical startups in the area.

Madison is also home to the University Research Park (URP), a 36-building non-profit research park and technology incubator. Housing 115 companies and over 4,100 employees, URP generates \$680M in economic output annually and generates state and local tax revenue exceeding \$46M each year. In addition, the URP induces or indirectly supports 5,000 additional jobs, including that of the newly opened Truliant Federal Credit Union on the research campus and the construction jobs supported by the new Accelerator addition being built. Many of the companies located within URP are based on research conducted at UW and licensed through the Wisconsin Alumni Research Foundation. Plans are currently underway to nearly double the size of URP by 2011, at which time the park will be home to more than 200 companies and provide jobs for up to 15,000 additional employees.

The emergence of Madison as a major player in the biopharmaceutical industry has brought non-tangible rewards to the local area as well. Madison was ranked as one of the nation's top 25 smartest cities, as a result of the high concentration of well-educated biopharmaceutical employees.

APPENDIX II: Methodology

This report presents an analysis of the impact of the biopharmaceutical sector on the economy of New York State. The analytics performed in this report attempt to quantify the absolute impact of the biopharmaceutical sector on the economy, rather than its marginal impact. An absolute approach considers all economic activity (direct, indirect, and induced) that is attributable to the sector’s presence; by contrast, a marginal approach acknowledges that a certain portion of this economic activity would still exist in the absence the sector, and thus only measures the additional economic activity that is unique to the sector’s presence in a given area. The absolute impact is a measure of the economic loss that would occur if the sector were to disappear, and was not replaced by anything, while the marginal impact is a measure of the economic loss that would result if the sector were to disappear, but had its labor and capital redeployed to other sectors. 2006 is the most recent year for which complete data sets were available for most of the economic impact analyses, at the time analyses were performed.

To quantify the sector’s impact on the New York State economy, this study measured common economic indicators, including employment and output. Employment is defined as the number of jobs supported by the sector. Output is the value of all sales generated by companies in the sector.

For the purposes of this study, the biopharmaceutical sector is composed of the extensive and diverse collection of companies that research and manufacture medications, from small start-up research firms to large and well-established organizations. Companies in this sector focus on the discovery, development, testing, and production of new biopharmaceutical products, and belong to one of the following sub-sectors: medicinal botanical manufacturing, pharmaceutical preparation manufacturing, in-vitro diagnostic substance manufacturing, biological product manufacturing, life sciences research, or biotechnology research. This report defines the biopharmaceutical sector and its sub-sectors using the North American Industry Classification System (NAICS). The sector includes the research and manufacturing companies associated with the NAICS codes the table below. For this study, this sector definition includes only private companies and excludes government agencies (e.g., National Institutes of Health). While this definition includes manufacturers of both brand and generic drugs, the vast majority of the sector’s economic activity is related to the discovery, development, and manufacture of brand medicines.

Biopharmaceutical Sector Definition

NAICS Code		NAICS Definition
3254: Pharmaceutical and Medicine Manufacturing	325411	Medicinal and Botanical Manufacturing
	325412	Pharmaceutical Preparation Manufacturing
	325413	In-Vitro Diagnostic Substance Manufacturing
	325414	Biological Product (except Diagnostic) Manufacturing
5417: Scientific Research and Development Services	541711	R&D in Biotechnology
	541712	R&D in Physical, Engineering & Life Sciences (except Biotechnology)

Multiplier Effect Analysis for Employment and Output

Considering only the direct employment and output of the biopharmaceutical sector understates its importance to the New York State economy. To fully capture the sector’s value in economic terms, this report provides an analysis of how the sector interacts with other components of the state economy, specifically in terms of how this interaction generates impact in other sectors. To do this, this report also includes the indirect and induced effects of the biopharmaceutical sector in its estimates of total economic impact. Indirect effects are those impacts associated with products and services required to support the direct impact of the biopharmaceutical sector. Induced effects are those impacts that are associated with products and services purchased with wages earned by direct and indirect sector participants. Therefore,

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indirect and induced should be accounted for when quantifying the absolute impact of the biopharmaceutical sector.

Consider an example of a biopharmaceutical company operating in the state of New York with 300 full-time jobs, employing scientists who are hired to conduct research, business and financial professionals who work on financing and commercializing the research, and administrative personnel who support daily operation. To assert that the biopharmaceutical company only supported 300 total jobs to the state economy may not be entirely accurate, as the company supports other jobs providing services to support the firm, its operations, and its employees. For example, these jobs include employment at accounting and law firms that are engaged by the biopharmaceutical company for various tax and legal services, and employment at janitorial services companies that are engaged by the biopharmaceutical company for daily upkeep and maintenance services. Furthermore, the combined presence of direct employees of the biopharmaceutical company and the indirect employees of the tax, law and janitorial firms (required to support the biopharmaceutical company) has effectively generated spending power (in the form of employee compensation) that will flow into the local economy. As these individuals become consumers of everyday goods and services such as groceries, dry cleaning, and real estate, their spending stimulates the local economy by creating demand for these products, and, thereby, supporting jobs in their respective sector.

To quantify the indirect and induced economic impacts for the biopharmaceutical sector, this report applied the “multiplier effect” concept, which is widely used for economic analyses such as this one. The U.S. Bureau of Economic Analysis (BEA), which itself provides tools to conduct multiplier effect analyses on the impacts of various economic projects, states that “analysis of economic impacts must account for the inter-industry relationships within regions because these relationships largely determine how regional economies are likely to respond to project and program changes.” The BEA also states that multipliers are an effective means to “account for inter-industry relationships within regions” and are “useful tools for conducting regional economic impact analysis.”ⁱⁱⁱ Multiplier effect analysis has been widely used to assess the significance of an industry to the national economy, or to the economies of states and other localities. Recent examples include the West Virginia University College of Business and Economicsⁱⁱⁱ report on the impact of the bioscience industry on the state economy, and the Sage Policy Group’s^{iv} similar report on bioscience in the state of Maryland.

The multiplier effect methodology translates a sector’s direct employment and output into indirect and induced metrics. At its core, multiplier analysis reflects the fact that a sector’s relationship with the local economy is such that the presence of one direct sector job or one dollar of sector output has a multiplicative effect that supports jobs and dollars of output in dependent sectors.

For this report, employment and output data was obtained from the Minnesota IMPLAN Group (MIG) along with software (IMPLAN®) to implement this economic analysis for New York State and each of the regions studied. All corrections performed were in line with those used in the report by Archstone Consulting LLC and Lawton R. Burns, Ph.D. “The Biopharmaceutical Sector’s Impact on the U.S. Economy: Analysis at the National, State, and Local Levels”.

Each geography studied in this report (i.e., New York State as a whole and each of the regions) was analyzed independently of each other, identifying each geographical location as an independent system. For each economic impact analysis, no attempts were made to measure impacts outside the system. Therefore, cross-border interactions (i.e., employment and output in New York State supported by biopharmaceutical activity in other states, or employment and output in a particular New York state region that is supported by biopharmaceutical activity in other New York state regions) were not measured.

However, note that when examining the U.S. as a whole, cross-border interactions between states and regions are taken into account since the interactions took place within the system (defined as the U.S. as a whole), yielding numerical results for the U.S. as a whole that would be higher than the sum of the

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individual states and Washington D.C. for employment and output. The difference for each of these measures is the estimated cross-border biopharmaceutical activity, or the indirect or induced activity resulting in one geographical location from the presence of the biopharmaceutical sector located in different geographical locations (e.g., a biopharmaceutical company located in California engaging the services of an accounting firm located in New York).

Note that in the report by Archstone Consulting LLC and Lawton R. Burns, Ph.D. “The Biopharmaceutical Sector’s Impact on the U.S. Economy: Analysis at the National, State, and Local Levels,” the cross-border biopharmaceutical activity for both output and employment were estimated for each state, approximating how much indirect and induced output and employment in a given state were due to biopharmaceutical activity in the other states. For each of these two metrics, the total indirect and induced cross-border biopharmaceutical activity was identified for each sector, and these totals were allocated to the fifty states and Washington D.C. based on the proportion of in-state activity in these geographical locations for each sector.

Since this report is concerned with New York State output and employment that is attributable to in-state biopharmaceutical economic activity. The results of this allocation were not presented in this report. As a result, New York statewide estimates of indirect and induced employment and output do not match the total indirect and induced figures as presented for New York State in the the report by Archstone Consulting LLC and Lawton R. Burns, Ph.D. “The Biopharmaceutical Sector’s Impact on the U.S. Economy: Analysis at the National, State, and Local Levels”.

Estimates of the employment and output impacts of ongoing New York State biopharmaceutical-related capital projects (University of Rochester’s Clinical and Translational Science Building, East River Science Park, BioBAT) were based on IMPLAN analysis of data contained in press articles about the cost of construction and estimated future employment of these institutions. Articles are referenced in the end notes. All analyses were conducted using the 2006 New York State IMPLAN data.

Employment and output estimates of the construction phase of these projects were obtained by using the total projected amount invested in each project as the output value for IMPLAN sectors 37 (new construction – manufacturing and industrial facilities) and 38 (new construction – commercial and institutional buildings). For the purposes of this report, a conservative assumption was made that 25% of capital investment projects are related to manufacturing and industrial facilities, while 75% are related to commercial and institutional buildings.

Employment and output estimates of the ongoing impact of these institutions were generated based on the biopharmaceutical employment that each institution is projected to sustain. For each project, an assumption about the nature (i.e. research intensive vs. manufacturing intensive) of the projected biopharmaceutical employment was used (University of Rochester CTSB, assumed 100% research, 0% manufacturing; East River Science Park, assumed 100% research, 0% manufacturing; BioBAT, assumed 75% research, 25% manufacturing), and separate IMPLAN impact analysis were run for each of the biopharmaceutical related sectors based on the output associated with the number of employees allocated to each IMPLAN sector.

Analysis of hypothetical scenarios based on New York State’s increase in direct biopharmaceutical output (as a percentage of U.S. direct biopharmaceutical output) were facilitated by the IMPLAN software and 2006 data for New York State. The additional direct biopharmaceutical output needed for New York State to account for 7.8% of the nation’s direct biopharmaceutical output (versus the state’s current 6.8%) was calculated. This difference was allocated to the biopharmaceutical-related IMPLAN sectors (i.e. research vs. manufacturing) per each of the three scenarios analyzed, and the IMPLAN software was used to derive output and employment estimates based on these hypothetical increases in direct output.

To determine the employment and output impact of ongoing New York State phase III clinical trials, data on the average costs of clinical trials were obtained from Clinical Trials Benchmarking and analyzed using

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the IMPLAN software. Given the average phase III clinical trial cost of \$26,000 per patient, the average number of patients in a phase III trial (20), and the total number of ongoing New York State clinical trials (1,249), an estimate of total cost of all New York State phase III clinical trials was developed. For the purposes of this report, it was assumed that 20% of this cost is provided to hospitals to run the trials, and this total was used as a basis for the impact analysis developed using the IMPLAN software and 2006 New York State data.

Other Analyses

Biopharmaceutical and All Other Sectors Employment Growth Rates, 1996-2006

To compute compound annual employment growth in the New York State biopharmaceutical sector and all other sectors from 1996 to 2006, employment estimates for both years were obtained from the Bureau of Labor Statistics (BLS) Quarterly Census of Employment and Wages (QCEW). The QCEW program publishes estimates of employment and wages for all states to the 6-digit NAICS level.

For biopharmaceutical employment in each geographical location studied, employment estimates for NAICS codes 54171 and 3254 were obtained for the year 1996 and 2006, and compound annual growth rates were computed accordingly. For employment growth in other sectors, QCEW employment figures were obtained for all industries and compound annual growth rates were computed once the biopharmaceutical employment totals were removed from each year.

New York State Biopharmaceutical Sector Occupational Profile

The occupational profile (i.e., percentage breakdown of employment by job type) of biopharmaceutical employment in New York was based on analysis of BLS Occupational Employment Statistics (OES) data obtained directly from the New York State Department of Labor. At the national level, the OES program publishes employment estimates by Standard Occupation Code (SOC) across all industries and also for specific industries to the 5-digit NAICS code level. For New York State, data were provided to the 4-digit NAICS code level (i.e., 3254 and 5417). SOC codes follow a hierarchical structure whereby the first 2 digits refer to the general occupation class (e.g., “management occupations”), while the last 4 digits specify the particular job type within the greater category.

For New York State, SOC employment estimates were obtained for NAICS industries 3254 and 5417. The number of employees listed in each 2-digit SOC code was summed, and a share was calculated for each SOC code as a percentage of total employment across all SOC codes for both industries. For the 2-digit SOC code entitled “Life, Physical and Social Science Occupations,” estimates of the prevalence of specific job types within this category were based on an analysis to the 6-digit SOC code level (per methods described above).

Per 10,000 Jobs Biopharmaceutical Employment

To analyze the geographical dispersion of biopharmaceutical employment in New York State (and relative to other states), the effects of population sizes were removed by examining employment on a per 10,000 job basis. “10,000 jobs” was selected as the basis, or denominator, for this analysis to yield results that were easily interpretable in terms of decimals (i.e., a per job basis would have yielded results that require many decimal places to observe significant digits).

Rates of biopharmaceutical employment per 10,000 jobs in each state were obtained with MIG-derived estimates of direct biopharmaceutical employment within each state, and were compared to MIG-derived employment figures for all other sectors. Note that the per 10,000 biopharmaceutical employment estimates presented in this report do not reflect the allocation of state jobs supported by out-of-state

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biopharmaceutical activity (see section “Multiplier Effect Analysis for Employment and Output” above) and therefore do not reflect those used in the Archstone Consulting report “The Impact of the Biopharmaceutical Sector on the U.S. Economy.”

Biopharmaceutical Wages

The wages earned by New York State biopharmaceutical employees were computed based on 2006 BLS QCEW data. QCEW total wages and total employment data were obtained from BLS for NAICS codes 3254 and 54171 (to represent biopharmaceutical sector) and for all sectors. Average wages per employee was defined as total wages divided by total employment. The biopharmaceutical average wage shown was derived as the weighted average of NAICS codes 3254 and 54171, weighed by MIG employment data. The wage data collected from NAICS codes 3254 and 54171 was assumed to be representative of the salaries earned for the firms associated with these sectors, and, therefore, no corrections were assumed necessary to derive biopharmaceutical wages associated with these sectors. Average wage for all other sectors was derived by removing biopharmaceuticals from both total wages and total employees prior to calculation.

As a basis of comparison, weighted averaged biopharmaceutical wages were calculated for the following counties in similar fashion: New York County (Manhattan), Nassau County, Suffolk County.

Biopharmaceutical State, Federal and Social Security Personal Income Tax Contributions

The state, federal, and social security income taxes paid by New York State biopharmaceutical employees were computed based on 2006 BLS QCEW average wage data, the National Bureau of Economic Research (NBER) TAXSIM 8.0 simulator, and MIG employment data.

New York State average wage data was computed from BLS QCEW employment and wages data for NAICS codes 3254 and 54171 to represent the biopharmaceutical sector, and for all sectors (see section “Biopharmaceutical Wages” for more information on methodology). Due to data availability (BLS data was not disclosed for NAICS 3254 and 54171 employment and wage data for the majority of regions studied), the New York statewide average wage data for 3254 and 54171 was used as a proxy for each of the regions. These average wage figures were then weighted according to the distribution of biopharmaceutical manufacturing vs. research employment in each region (based on the corresponding MIG sector). State and federal tax liability, including social security, for 2006 was computed for each biopharmaceutical NAICS code and for all other sectors (defined as all sectors less biopharmaceutical NAICS codes) based on the average wage for each biopharmaceutical NAICS code and for all other sectors and the following tax assumptions for household characteristics: married, joint-filing status, one dependent under the age of 17, and \$4,000 in annual contribution to retirement account.

Once average employee state and federal tax (including social security) liabilities were calculated for each for each biopharmaceutical NAICS code and for all other sectors in New York State and the regions studied, the average tax liabilities were multiplied by the corresponding number of employees in each corresponding MIG sector for that geography. Note that the average wage of all other sectors include contributions of NAICS codes 3254 and 54171 not associated with biopharmaceuticals (54171 code was used as a proxy for the parent NAICS code 5417).

Biopharmaceutical Establishments in New York State

Estimates of the number of biopharmaceutical establishments in New York State and each of the regions studied were based on BLS QCEW data. The program provides data on establishments to the 6-digit NAICS level for all states and counties. Data was obtained for New York State and all counties associated with each region for NAICS codes 3254 and 5417. To estimate the number of establishments

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within these NAICS that were truly engaged in biopharmaceutical research and manufacturing, these totals were downward-adjusted (for each NAICS) using the correction factors applied to the MIG NAICS-based data (see section “Multiplier Effect Analysis for Employment and Output” above).

Active Clinical Trials in New York State

To determine clinical trial activity, data was downloaded from clinicaltrials.gov in September 2008 for analysis, resulting in a database supplied by The Lewin Group. A clinical trial is a scientific study, examining the clinical benefits and risks of a compound to be used for medicinal purposes. A trial can be for a compound in development seeking FDA approval or for a compound already approved by the FDA.

The clinical trial analysis examines active trials targeting nine condition categories: heart disease, behaviors and mental disorders, cancers and other neoplasms, rare diseases, respiratory tract diseases, diabetes, HIV/AIDS, Alzheimer’s disease, and Parkinson’s disease. To assign clinical trials to these nine condition categories, the Lewin Group first relied upon the categories provided by clinicaltrials.gov^v and supplemented these category definitions with guidance from a pharmacist on staff at PhRMA. Additionally, because clinicaltrials.gov does not provide a complete list of condition names for each category, the Lewin Group supplemented the clinicaltrials.gov categorization whenever possible. For example, the “cancers and other neoplasms” category did not include all types of cancers, such as breast cancer and lung cancer. To address this issue, any time “cancer” was included in a condition name, we assigned the clinical trial targeting that condition to the “cancer and other neoplasms” category.

Due to the large number of condition names and the slight variations in how the names are reported in the clinicaltrials.gov data, every trial was not assigned to a condition grouping. The counts of trials by condition grouping for these nine condition categories may therefore be understated.

When a clinical trial targets more than one condition, the Lewin Group counted the trial once for each of the conditions it targets. For example, a trial of treatments for both breast cancer and diabetes would be counted once in the “cancers and other neoplasms” category and once in the “diabetes” category. The U.S. total includes unique counts of clinical trials by condition category, counting a clinical trial only once if it is conducted in multiple states.

Venture Capital Investments

To determine venture capital activity, data was downloaded from PricewaterhouseCoopers’s Money Tree database for analysis. Data analyzed was for the category “biotechnology,” and, therefore, some data may be for sectors beyond biopharmaceuticals, such as agriculture, but still rely on biotechnology as the core technology platform.

Biopharmaceutical Company Investments in R&D

To determine 2006 R&D spending by the biopharmaceutical sector in New York State, U.S. national data was sourced from PhRMA and Burrill & Company in PhRMA’s *2008 Industry Profile*. To determine state-by-state allocations of this R&D expenditure total, data was obtained from the National Science Foundation (NSF) 2006 survey of industrial R&D. Estimates of each state’s industrial R&D expenditure by 4-digit NAICS code were analyzed for NAICS codes 3254 and 5417, and the state’s relative percent contribution to total 3254 and 5417 expenditures was applied to the U.S. total derived by PhRMA/Burrill. Due to NSF non-disclosure of 3254 and 5417 expenditure estimates for certain states, the sum of all states’ 3254 and 5417 R&D investment did not add up to the U.S. total. This difference was allocated back to non-disclosed states based on BLS estimates of employment for each of these NAICS in the given state. The national total figures from PhRMA/Burrill were used due to the underestimation of industry expenditures in NSF’s methodology, as identified by F. M. Scherer.^{vi}

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National Institutes of Health Grants

To determine the value of National Institutes of Health grant funding in 2006, data from the NIH database of awards by state and foreign site was analyzed.

Capital Projects

Expenditures on capital projects in biopharmaceutical-related fields in New York State were obtained from the NSF Survey of Science and Engineering Research Facilities. The survey is a biennial project conducted by the NSF to gain insight into the creation and renovation of science and engineering infrastructure at academic and biomedical institutions. Expenditures on new and renovated facilities were grouped into projects started in fiscal years 2004-2005 and those planned for 2006-2007, and figures are presented in nominal terms.

Endnotes – Appendix I: Methodology

- ⁱ Archstone Consulting LLC and Lawton R. Burns, Ph.D, “The Biopharmaceutical Sector’s Impact on the U.S. Economy: Analysis at the National, State, and Local Levels” (2009)
- ⁱⁱ U.S. Department of Commerce (U.S. Bureau of Economic Analysis). (2008). Regional Multipliers from the Regional Input-Output Modeling System (RIMS II): A Brief Description. Available: <http://www.bea.gov/regional/rims/brfdesc.cfm> (Accessed October 14, 2008).
- ⁱⁱⁱ A.C. Gregory and T. S. Witt. (2008). An Economic Profile of the Biosciences Industry in West Virginia. West Virginia University Research Corporation, February 2008.
- ^{iv} Sage Policy Group, Inc. (2007). Maryland: The Nation’s Bioscience Leader.
- ^v United States Department of Health & Human Services (National Institutes of Health). (2008). Clinical Trial Conditions by Category. Available: http://www.clinicaltrials.gov/ct2/search/browse?brwse=cond_cat (Accessed February 2, 2008).
- ^{vi} F. M. Scherer (2007). *Pharmaceutical Innovation* (This paper has been written for a forthcoming Handbook on the Economics of Technical Change, Bronwyn Hall and Nathan Rosenberg, editors).

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APPENDIX II: DATA TABLES

New York State: Indirect Biopharmaceutical Employment, 2006		
Sector	Employment	Percentage
Wholesale trade	4,546	11.8%
Employee placement / recruitment agencies and staffing companies	3,614	9.4%
Company management / holding companies	3,009	7.8%
Real estate management	1,627	4.2%
Legal services	1,403	3.6%
Janitorial, pest control and other cleaning and landscaping services	1,390	3.6%
Warehousing and storage companies	1,229	3.2%
Non-pharmaceutical chemical manufacturing	1,198	3.1%
Accounting, tax preparation and bookkeeping services	1,127	2.9%
Food services and drinking places	1,068	2.8%
Architectural and engineering services	991	2.6%
Advertising and related services	875	2.3%
Management consulting services	833	2.2%
Colleges, universities, and junior colleges	785	2.0%
Social, professional, labor and political associations	749	1.9%
Maintenance and repair of nonresidential buildings	726	1.9%
Investigation and security services	632	1.6%
Couriers and messengers	594	1.5%
Business support services	543	1.4%
Miscellaneous professional, scientific and technical services	539	1.4%
Other	11,112	28.8%
Total	38,590	100.0%

New York State: Induced Biopharmaceutical Employment, 2006		
Sector	Employment	Percentage
Food services and drinking places	3,663	10.1%
Hospitals	2,322	6.4%
Offices of physicians, dentists, and other health practitioners	2,236	6.1%
Food and beverage stores	1,467	4.0%
Wholesale trade	1,447	4.0%
Nursing and residential care facilities	1,306	3.6%
Social assistance (e.g., community food / housing and emergency relief), except child day care services	1,286	3.5%
Real estate management	979	2.7%
Colleges, universities, and junior colleges	964	2.6%
Department and other general merchandise stores	948	2.6%
Private household services (e.g., nannies)	938	2.6%
Motor vehicle and parts dealers	660	1.8%
Home health care services	656	1.8%
Child day care services	615	1.7%
Miscellaneous store retailers (e.g., florists, pet / pet supply stores, office supply stores)	594	1.6%
Clothing and clothing accessories stores	571	1.6%
Employee placement / recruitment agencies and staffing companies	561	1.5%
Elementary and secondary schools	537	1.5%
Building material and garden supply stores	511	1.4%
Other ambulatory health care services	499	1.4%
Other	13,668	37.5%
Total	36,428	100.0%

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New York City: Indirect Biopharmaceutical Employment, 2006		
Sector	Employment	Percentage
Employee placement / recruitment agencies and staffing companies	914	17.0%
Wholesale trade	413	7.7%
Real estate management	359	6.7%
Janitorial, pest control, other cleaning and landscaping services	279	5.2%
Legal services	247	4.6%
Company management / holding companies	212	3.9%
Architectural and engineering services	202	3.8%
Accounting, tax preparation and bookkeeping services	159	3.0%
Food services and drinking places	156	2.9%
Investigation and security services	144	2.7%
Management consulting services	143	2.7%
Social, professional, labor and political associations	133	2.5%
Maintenance and repair of nonresidential buildings	113	2.1%
Postal service	106	2.0%
Advertising and related services	96	1.8%
Computer systems design services	92	1.7%
Office administrative services	86	1.6%
Business support services	82	1.5%
Miscellaneous professional, scientific and technical services	74	1.4%
Couriers and messengers	71	1.3%
Other	1,290	24.0%
Total	5,371	100.0%

New York City: Induced Biopharmaceutical Employment, 2006		
Sector	Employment	Percentage
Food services and drinking places	541	11.3%
Hospitals	351	7.3%
Offices of physicians, dentists, and other health practitioners	250	5.2%
Social assistance (e.g., community food / housing and emergency relief), except child day care services	207	4.3%
Wholesale trade	198	4.1%
Nursing and residential care facilities	191	4.0%
Food and beverage stores	175	3.7%
Colleges, universities, and junior colleges	149	3.1%
Private household services (e.g., nannies)	145	3.0%
Real estate management	137	2.9%
Home health care services	116	2.4%
Department and general merchandise stores	88	1.8%
Elementary and secondary schools	84	1.8%
Child day care services	83	1.7%
Other ambulatory health care services	78	1.6%
Employee placement / recruitment agencies and staffing companies	76	1.6%
Miscellaneous store retailers (e.g., florists, pet / pet supply stores, office supply stores)	73	1.5%
Clothing and clothing accessories stores	73	1.5%
Health and personal care stores	70	1.5%
Personal care services	68	1.4%
Other	1,646	34.3%
Total	4,798	100.0%

Appendix - Economic Impact of Biopharmaceutical Sector on New York State

Buffalo: Indirect Biopharmaceutical Employment, 2006		
Sector	Employment	Percentage
Employee placement / recruitment agencies and staffing companies	375	11.0%
Wholesale trade	373	11.0%
Company management / holding companies	325	9.6%
Legal services	179	5.3%
Janitorial, pest control, other cleaning and landscaping services	139	4.1%
Real estate management	105	3.1%
Accounting, tax preparation and bookkeeping services	96	2.8%
Food services and drinking places	95	2.8%
Non-pharmaceutical chemical manufacturing	87	2.6%
Social, professional, labor and political associations	77	2.3%
Architectural and engineering services	72	2.1%
Warehousing and storage companies	63	1.9%
Maintenance and repair of nonresidential buildings	61	1.8%
Hotels and motels, including casino hotels	57	1.7%
Colleges, universities, and junior colleges	54	1.6%
Credit card companies and other credit issuing agencies	52	1.5%
Management consulting services	51	1.5%
Investigation and security services	50	1.5%
Miscellaneous professional, scientific and technical services	50	1.5%
Computer systems design services	48	1.4%
Other	984	29.0%
Total	3,396	100.0%

Buffalo: Induced Biopharmaceutical Employment, 2006		
Sector	Employment	Percentage
Food services and drinking places	304	10.8%
Offices of physicians, dentists, and other health practitioners	175	6.3%
Hospitals	156	5.6%
Food and beverage stores	123	4.4%
Wholesale trade	114	4.1%
Nursing and residential care facilities	104	3.7%
Department and general merchandise stores	91	3.3%
Social assistance (e.g., community food / housing and emergency relief), except child day care services	90	3.2%
Motor vehicle and parts dealers	80	2.9%
Clothing and clothing accessories stores	62	2.2%
Colleges, universities, and junior colleges	61	2.2%
Real estate management	57	2.0%
Child day care services	54	1.9%
Building material and garden supply stores	48	1.7%
Employee placement / recruitment agencies and staffing companies	47	1.7%
Miscellaneous store retailers (e.g., florists, pet / pet supply stores, office supply stores)	46	1.6%
Home health care services	45	1.6%
Legal services	44	1.6%
Non-store retailers (e.g., internet / mail order retailers)	41	1.5%
Social, professional, labor and political organizations	41	1.4%
Other	1,015	36.3%
Total	2,798	100.0%

Appendix - Economic Impact of Biopharmaceutical Sector on New York State

Capital District: Indirect Biopharmaceutical Employment, 2006		
Sector	Employment	Percentage
Employee placement / recruitment agencies and staffing companies	643	18.0%
Wholesale trade	228	6.4%
Legal services	198	5.6%
Company management / holding companies	186	5.2%
Real estate management	184	5.2%
Janitorial, pest control, other cleaning and landscaping services	161	4.5%
Architectural and engineering services	107	3.0%
Social, professional, labor and political associations	98	2.7%
Maintenance and repair of nonresidential buildings	95	2.7%
Accounting, tax preparation and bookkeeping services	94	2.6%
Food services and drinking places	93	2.6%
Management consulting services	79	2.2%
Computer systems design services	64	1.8%
Hotels and motels, including casino hotels	63	1.8%
Warehousing and storage companies	59	1.7%
Postal service	55	1.5%
Office administrative services	54	1.5%
Miscellaneous professional, scientific and technical services	53	1.5%
Investigation and security services	51	1.4%
Business support services	48	1.3%
Other	954	26.7%
Total	3,565	100.0%

Capital District: Induced Biopharmaceutical Employment, 2006		
Sector	Employment	Percentage
Food services and drinking places	507	10.2%
Offices of physicians, dentists, and other health practitioners	305	6.1%
Hospitals	283	5.7%
Food and beverage stores	206	4.2%
Department and general merchandise stores	190	3.8%
Wholesale trade	184	3.7%
Nursing and residential care facilities	179	3.6%
Social assistance (e.g., community food / housing and emergency relief), except child day care services	154	3.1%
Motor vehicle and parts dealers	130	2.6%
Colleges, universities, and junior colleges	120	2.4%
Clothing and clothing accessories stores	118	2.4%
Real estate management	116	2.3%
Miscellaneous store retailers (e.g., florists, pet / pet supply stores, office supply stores)	88	1.8%
Employee placement / recruitment agencies and staffing companies	87	1.8%
Building material and garden supply stores	84	1.7%
Child day care services	81	1.6%
Non-store retailers (e.g., internet / mail order retailers)	76	1.5%
Health and personal care stores	72	1.5%
Insurance companies	72	1.4%
Social, professional, labor and political associations	70	1.4%
Other	1,834	37.0%
Total	4,958	100.0%

Appendix - Economic Impact of Biopharmaceutical Sector on New York State

Ithaca: Indirect Biopharmaceutical Employment, 2006		
Sector	Employment	Percentage
Employee placement / recruitment agencies and staffing companies	4	8.3%
Architectural and engineering services	4	7.8%
Social, professional, labor and political organizations	3	5.4%
Legal services	3	5.3%
Food services and drinking places	2	5.1%
Real estate management	2	5.0%
Janitorial, pest control, other cleaning and landscaping services	2	3.8%
Hotels and motels, including casino hotels	2	3.6%
Accounting, tax preparation and bookkeeping services	2	3.5%
Wholesale trade	2	3.1%
Computer systems design services	1	2.9%
Glass and glass products, except glass containers	1	2.9%
Commercial printing	1	2.9%
Maintenance and repair of nonresidential buildings	1	2.8%
Miscellaneous professional, scientific and technical services	1	2.4%
Commercial banks, savings institutions and credit unions	1	2.0%
Management consulting services	1	1.7%
Postal service	1	1.7%
Other state and local government enterprises	1	1.6%
Newspaper publishers	1	1.6%
Other	13	26.7%
Total	49	100.0%

Ithaca: Induced Biopharmaceutical Employment, 2006		
Sector	Employment	Percentage
Hospitals	14	15.9%
Food services and drinking places	10	11.5%
Offices of physicians, dentists, and other health practitioners	6	6.5%
Food and beverage stores	4	4.6%
Nursing and residential care facilities	4	4.2%
Social assistance (e.g., community food / housing and emergency relief), except child day care services	3	3.3%
Department and general merchandise stores	3	3.1%
Private household services (e.g., nannies)	3	3.0%
Colleges, universities, and junior colleges	3	2.8%
Motor vehicle and parts dealers	2	2.5%
Clothing and clothing accessories stores	2	2.4%
Child day care services	2	2.2%
Building material and garden supply stores	2	2.2%
Miscellaneous store retailers (e.g., florists, pet / pet supply stores, office supply stores)	1	1.6%
Commercial banks, savings institutions and credit unions	1	1.6%
Gasoline stations	1	1.5%
Social, professional, labor and political organizations	1	1.3%
Other ambulatory health care services	1	1.2%
Health and personal care stores	1	1.2%
Non-store retailers (e.g., internet / mail order retailers)	1	1.2%
Other	24	26.3%
Total	91	100.0%

Appendix - Economic Impact of Biopharmaceutical Sector on New York State

Long Island: Indirect Biopharmaceutical Employment, 2006		
Sector	Employment	Percentage
Wholesale trade	1,275	13.5%
Company management / holding companies	1,229	13.0%
Employee placement / recruitment and staffing companies	503	5.3%
Legal services	437	4.6%
Non-pharmaceutical chemical manufacturing	393	4.2%
Real estate management	341	3.6%
Accounting, tax preparation and bookkeeping services	308	3.2%
Janitorial, pest control, other cleaning and landscaping services	265	2.8%
Food services and drinking places	244	2.6%
Warehousing and storage companies	239	2.5%
Colleges, universities, and junior colleges	232	2.5%
Advertising and related services	223	2.4%
Management consulting services	209	2.2%
Architectural and engineering services	194	2.0%
Maintenance and repair of nonresidential buildings	189	2.0%
Commercial banks, savings institutions and credit unions	160	1.7%
Miscellaneous professional, scientific and technical services	147	1.6%
Credit card companies and other credit issuing agencies	147	1.6%
Truck transportation	121	1.3%
Business support services	116	1.2%
Other	2,501	26.4%
Total	9,475	100.0%

Long Island: Induced Biopharmaceutical Employment, 2006		
Sector	Employment	Percentage
Food services and drinking places	646	9.5%
Offices of physicians, dentists, and other health practitioners	434	6.4%
Hospitals	373	5.5%
Wholesale trade	254	3.7%
Food and beverage stores	246	3.6%
Social assistance (e.g., community food / housing and emergency relief), except child day care services	237	3.5%
Nursing and residential care facilities	231	3.4%
Department and general merchandise stores	212	3.1%
Colleges, universities, and junior colleges	193	2.8%
Private household services (e.g., nannies)	181	2.7%
Real estate management	172	2.5%
Motor vehicle and parts dealers	162	2.4%
Clothing and clothing accessories stores	139	2.1%
Child day care services	133	2.0%
Miscellaneous store retailers (e.g., florists, pet / pet supply stores, office supply stores)	131	1.9%
Elementary and secondary schools	123	1.8%
Building material and garden supply stores	115	1.7%
Home health care services	113	1.7%
Insurance companies	107	1.6%
Health and personal care stores	99	1.5%
Other	2,477	36.5%
Total	6,779	100.0%

Appendix - Economic Impact of Biopharmaceutical Sector on New York State

Rochester: Indirect Biopharmaceutical Employment, 2006		
Sector	Employment	Percentage
Company management / holding companies	274	11.6%
Wholesale trade	234	9.9%
Employee placement / recruitment agencies and staffing companies	204	8.7%
Legal services	105	4.5%
Warehousing and storage companies	87	3.7%
Real estate management	86	3.6%
Non-pharmaceutical and chemical manufacturing	85	3.6%
Accounting, tax preparation and bookkeeping services	79	3.3%
Food services and drinking places	72	3.1%
Janitorial, pest control, other cleaning and landscaping services	67	2.9%
Advertising and related services	56	2.4%
Colleges, universities, and junior colleges	56	2.4%
Architectural and engineering services	52	2.2%
Management consulting services	44	1.8%
Commercial printing	43	1.8%
Hotels and motels, including casino hotels	42	1.8%
Newspaper publishers	41	1.7%
Social, professional, labor and political associations	39	1.7%
Maintenance and repair of nonresidential buildings	39	1.7%
Miscellaneous professional, scientific and technical services	33	1.4%
Other	622	26.4%
Total	2,359	100.0%

Rochester: Induced Biopharmaceutical Employment, 2006		
Sector	Employment	Percentage
Food services and drinking places	173	11.1%
Hospitals	101	6.5%
Offices of physicians, dentists, and other health practitioners	94	6.1%
Food and beverage stores	67	4.3%
Nursing and residential care facilities	59	3.8%
Social assistance (e.g., community food / housing and emergency relief), except child day care services	54	3.5%
Department and general merchandise stores	51	3.3%
Real estate management	44	2.8%
Wholesale trade	44	2.8%
Motor vehicle and parts dealers	43	2.8%
Colleges, universities, and junior colleges	38	2.4%
Child day care services	33	2.1%
Non-store retailers (e.g., internet / mail order retailers)	30	1.9%
Miscellaneous store retailers (e.g., florists, pet / pet supply stores, office supply stores)	28	1.8%
Employee placement / recruitment agencies and staffing companies	28	1.8%
Clothing and clothing accessories stores	27	1.7%
Building material and garden supply stores	26	1.7%
Home health care services	23	1.5%
Elementary and secondary schools	22	1.4%
Legal services	22	1.4%
Other	551	35.4%
Total	1,556	100.0%

Appendix - Economic Impact of Biopharmaceutical Sector on New York State

Syracuse: Indirect Biopharmaceutical Employment, 2006		
Sector	Employment	Percentage
Wholesale trade	253	12.3%
Company management / holding companies	195	9.5%
Employee placement / recruitment agencies and staffing companies	192	9.3%
Warehousing and storage companies	89	4.3%
Legal services	87	4.2%
Real estate management	83	4.0%
Janitorial, pest control, other cleaning and landscaping services	71	3.4%
Accounting, tax preparation and bookkeeping services	62	3.0%
Food services and drinking places	56	2.7%
Non-pharmaceutical chemical manufacturing	53	2.6%
Architectural and engineering services	48	2.4%
Miscellaneous professional, scientific and technical services	43	2.1%
Maintenance and repair of nonresidential buildings	41	2.0%
Colleges, universities, and junior colleges	40	1.9%
Advertising and related services	36	1.8%
Radio and television broadcasting	35	1.7%
Hotels and motels, including casino hotels	35	1.7%
Newspaper publishers	34	1.7%
Truck transportation	32	1.5%
Management consulting services	31	1.5%
Other	545	26.5%
Total	2,060	100.0%

Syracuse: Induced Biopharmaceutical Employment, 2006		
Sector	Employment	Percentage
Food services and drinking places	162	10.5%
Hospitals	86	5.6%
Offices of physicians, dentists, and other health practitioners	83	5.4%
Food and beverage stores	67	4.3%
Wholesale trade	65	4.2%
Nursing and residential care facilities	57	3.7%
Department and general merchandise stores	55	3.6%
Social assistance (e.g., community food / housing and emergency relief), except child day care services	55	3.6%
Motor vehicle and parts dealers	43	2.8%
Real estate management	43	2.8%
Clothing and clothing accessories stores	40	2.6%
Colleges, universities, and junior colleges	39	2.5%
Child day care services	29	1.9%
Building material and garden supply stores	26	1.7%
Private household services (e.g., nannies)	24	1.6%
Employee placement / recruitment agencies and staffing companies	24	1.5%
Miscellaneous store retailers (e.g., florists, pet / pet supply stores, office supply stores)	24	1.5%
Commercial banks, savings institutions and credit unions	23	1.5%
Health and personal care stores	22	1.4%
Non-store retailers (e.g., internet / mail order retailers)	22	1.4%
Other	554	35.9%
Total	1,543	100.0%

Appendix - Economic Impact of Biopharmaceutical Sector on New York State

Westchester: Indirect Biopharmaceutical Employment, 2006		
Sector	Employment	Percentage
Wholesale trade	778	14.3%
Company management / holding companies	431	7.9%
Legal services	282	5.2%
Non-pharmaceutical chemical manufacturing	252	4.6%
Real estate management	235	4.3%
Employee placement / recruitment agencies and staffing companies	211	3.9%
Accounting, tax preparation and bookkeeping services	206	3.8%
Colleges, universities, and junior colleges	181	3.3%
Janitorial, pest control, other cleaning and landscaping services	178	3.3%
Advertising and related services	178	3.3%
Management consulting services	138	2.5%
Architectural and engineering services	124	2.3%
Maintenance and repair of nonresidential buildings	121	2.2%
Food services and drinking places	121	2.2%
Commercial banks, savings institutions and credit unions	98	1.8%
Miscellaneous professional, scientific and technical services	96	1.8%
Credit card companies and other credit issuing agencies	80	1.5%
Hotels and motels, including casino hotels	78	1.4%
Investigation and security services	76	1.4%
Plastics plumbing fixtures and all other plastics products	71	1.3%
Other	1,518	27.8%
Total	5,453	100.0%

Westchester: Induced Biopharmaceutical Employment, 2006		
Sector	Employment	Percentage
Food services and drinking places	410	7.7%
Offices of physicians, dentists, and other health practitioners	350	6.6%
Hospitals	283	5.3%
Social assistance (e.g., community food / housing and emergency relief), except child day care services	216	4.1%
Food and beverage stores	214	4.0%
Nursing and residential care facilities	202	3.8%
Private household services (e.g., nannies)	191	3.6%
Wholesale trade	187	3.5%
Colleges, universities, and junior colleges	183	3.4%
Real estate management	166	3.1%
Department and general merchandise stores	154	2.9%
Clothing and clothing accessories stores	122	2.3%
Child day care services	114	2.1%
Home health care services	109	2.0%
Motor vehicle and parts dealers	103	1.9%
Elementary and secondary schools	92	1.7%
Legal services	86	1.6%
Health and personal care stores	82	1.5%
Other ambulatory health care services	80	1.5%
Miscellaneous store retailers (e.g., florists, pet / pet supply stores, office supply stores)	75	1.4%
Other	1,899	35.7%
Total	5,317	100.0%

Appendix - Economic Impact of Biopharmaceutical Sector on New York State

Binghamton: Indirect Biopharmaceutical Employment, 2006		
Sector	Employment	Percentage
Employee placement / recruitment agencies and staffing companies	31	26.7%
Janitorial, pest control, other cleaning and landscaping services	9	8.0%
Real estate management	6	4.8%
Legal services	5	4.7%
Social, professional, labor and political associations	5	4.5%
Maintenance and repair of nonresidential buildings	4	3.6%
Architectural and engineering services	4	3.4%
Food services and drinking places	4	3.1%
Accounting, tax preparation and bookkeeping services	3	2.8%
Postal service	3	2.2%
Business support services	2	2.1%
Hotels and motels, including casino hotels	2	2.0%
Office administrative services	2	1.8%
Wholesale trade	2	1.5%
Telecommunications	2	1.3%
Management consulting services	1	1.3%
Other State and local government enterprises	1	1.1%
Truck transportation	1	1.1%
Computer systems design services	1	1.0%
Investigation and security services	1	1.0%
Other	26	22.0%
Total	116	100.0%

Binghamton: Induced Biopharmaceutical Employment, 2006		
Sector	Employment	Percentage
Food services and drinking places	11	11.9%
Hospitals	6	6.8%
Offices of physicians, dentists, and other health practitioners	6	6.3%
Food and beverage stores	5	5.0%
Department and general merchandise stores	4	4.6%
Nursing and residential care facilities	4	4.2%
Social assistance (e.g., community food / housing and emergency relief), except child day care services	3	3.5%
Motor vehicle and parts dealers	3	3.4%
Clothing and clothing accessories stores	2	2.6%
Building material and garden supply stores	2	2.1%
Health and personal care stores	2	2.0%
Miscellaneous store retailers (e.g., florists, pet / pet supply stores, office supply stores)	2	1.8%
Non-store retailers (e.g., internet / mail order retailers)	2	1.8%
Social, professional, labor and political associations	2	1.7%
Real estate management	1	1.6%
Other educational services (e.g., technical / trade / language schools, tutoring, sports instruction)	1	1.6%
Wholesale trade	1	1.6%
Employee placement / recruitment agencies and staffing companies	1	1.6%
Personal care services	1	1.6%
Home health care services	1	1.5%
Other	30	32.9%
Total	91	100.0%